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Houses of Experiment

Modern housing and the will to laboratorization

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Abstract

This paper adds historical and geographical specificity to the link between city building and laboratorization processes. It does so by way of the example of housing in mid-Twentieth Century Britain. Housing provision at this time was shaped by an intensification of the relationship between architectural design and science, both via the emergent field of building science and a new social science of householder expectations, satisfactions and behaviour. The paper focuses on two instances of these sciences in action in the production of British modern housing. The first instance deals with a set of experiments conducted on ventilation and heating in Britain's Building Research Station. The second instance on the social science of a post-occupancy study of multi-storey flats in Glasgow. The paper argues that mid-Twentieth Century housing construction and provision was structured in and through a laboratory logic which had a complex geography and temporality. The science of housing sees the conflation and hybridization of the space of the laboratory, the site of the house and the action of the experiment.

Keywords: laboratory; housing science; building science; experiment

Introduction

In mid-Twentieth Century Britain the design of housing was undergoing a revolutionary change. At this point in time housing design (as with much other building design) became self consciously scientific. Indeed, in this era variations of architectural modernism (notably the high-rise), housing modernization through new standards (of floor space, ventilation and heating), and innovative methods of applied scientific inquiry coalesced to produce an unprecedented era of state-endorsed and funded experimentation, all in the name of housing. It has become commonplace for critics to refer to the high-rise flats built at this time as 'experiments' in building technology (Ravetz, 2001: 104; see also Dunleavy, 1981; Coleman 1985; Hall, 1988; Power, 1993; Glendinning and Muthesius, 1994) and even, as Hanley (2006; 105) puts it, 'experimenting with lives'. While the high-rise typology stands as one of the most controversial markers of an era of housing experimentation, in truth there was experimentation and laboratorization extending throughout the field of housing design and provision. Post-war housing reform in Britain was ambitious. It sought not only to clear away slum housing but also, through mass public housing provision, abolish the class-based disparities that threatened social cohesion. Britain's housing programme was what Dunleavy (1981: 100) dubbed a 'technological shortcut to social change', and scientific research in building technology and sociology shored up that wider experiment.

Conventionally the art of architectural design and science were separate spheres. For example, architecture was taught through the study of what went before, and science was taught through the experiment (Cowen 1978). Scientists were conventionally understood to be analytical and diagnose the nature of what exists, while architects were understood as creative and invented the new (Cross 2001). This separation was challenged with modernism which eschewed past templates and drew upon, and sought to express, technological and engineering advances as never before. Scientific methods also gave modernist architecture new tools by which to measure its purpose and performance. This complex relationship between science and architecture has been the focus of considerable scholarship (Banham, 1960; Frampton, 1996, 1999; Galison and Thompson, 1999; Picon, 1999; Forty, 1999). Writing in 1928 about the emergent modernist architectural avant-garde, Sigfried Giedion noted that there was a new self-conscious, 'internalisation' of science. This he linked, on the one hand, to the production of an entirely new modern house type, that offered the '[g]reatest possible overcoming of gravity. Light proportions. Openness, free flow of air' (Giedion 1995(1928): 93). Giedion noted how the 'engineer-constructor' had started to 'encroach' or 'press', as he put it, on the territory of the architect, as did new and 'more rapid, industrial means of design' (94). In short, architectural design, conceived of as an arts practice in which applied knowledge and standards created by and circulating within an architectural élite, was giving way to another kind of design practice, what Giedion called 'collective design' (99). Science

was part of that collective, as was the space of the laboratory and the method of the experiment. For example by the mid-Twentieth Century the UK university sector exhibited evidence of the scientification of architecture in new pedagogies like the 'design method movement' (Broadbent and Ward, 1969; Cross, 2001) and newly formed building science departments (Courtney, 1997). So paramount was science in the thinking of architectural practice at this time that architectural technologist Buckminster Fuller could declare that the 1960s was the 'design science decade' (quoted in Baldwin, 1996: 25).

In what follows we examine the role that building science and social science played in producing useable facts that became either the scientific basis for statements of building standards or the aim of post-construction building performance evaluations, both of which sought to, and at times actually did, re-shape housing design. More centrally, we look at the role played in the architecture/science collective design process by laboratory and field-based science. The space of science manifested in various ways in British housing provision of the time. There were new purpose-built building science laboratories created, many of which were occupied houses as well. Existing, lived-in houses had systematic building science experiments embedded into them. And already built, lived-in housing considered to be experimental had social science applied to it. In this paper we will discuss in detail just two of these types, that being the purpose-built, building science laboratories at Britain's innovative Building Research Station, and the field-based, post-occupancy social science conducted on high-rise houses. We examine closely the ways in which the experimental space and the house space are inter-twined such that the distinction between the space that houses the experiment (conventionally the laboratory) and the experiment itself blur. We also look at the variable abilities of these scientific spaces to create laboratory conditions and, consequently, plausible housing facts that could travel out from the site of science and re-shape a wider world of housing. In this sense our scholarship also speaks back to that wider tradition of scholarship that has concerned itself with the spaces and places of science making (Latour and Woolgar, 1979; Latour, 1983; Shapin, 1988; Forgan, 1989; James, 1989; Lynch, 1991; Ophir et al., 1991; Knorr Cetina, 1992, 2001; Livingstone, 1995, 2000; Kulick and Kohler, 1996; Latour, 1999; Driver, 2000; Gieryn 2002a, 2002b, 2006).

Knorr-Cetina (2001: 8233) refers to the laboratory as 'a "house" for the conduct of experiments' (see also Shapin, 1988). The metaphor of the house is both useful and resonant for our purposes. Like a house, the laboratory space enacts a withdrawal from the world at large. It creates a space of relative privacy that allows for certain kinds of experiments, including those associated with technological innovations, to happen in a controlled manner and with limited impact on the 'real' (non-laboratory) world outwith. If something goes right in a laboratory, then it links into knowledges (facts, standards) and technologies (drugs, machines, procedures, patents) and networks (production lines, other laboratories) that allow it to move out of the originating laboratory and do work elsewhere. If something goes

wrong in a laboratory then, usually, the scale and scope of that error has been controlled sufficiently well for it not to matter: or to matter productively, such that the error can feed into on-going experimental practice and fact building. Being removed from the rest of the world (being separated out and with those links controlled) is a part of the logic of the scientific laboratory, what Kohler (2002: 14) calls 'placeless places'. So too, is the logic of substitution, whereby the real world is represented by parts or fragments that are of a manageable scale such that they can be handled, isolated and controlled in ways they can not be if in a natural or real world setting. Knorr-Cetina refers to this as re- or de-location. Again usefully for us, Knorr-Cetina finds herself returning to the metaphor of the home with respect to this attribute of the laboratory. Laboratory sciences, she says, 'bring objects "home" [to the laboratory] and manipulates them "on their own terms" '. We might note here an intrinsic contradiction: work Knorr-Cetina dubs as 'homing in' (8234) is in fact the making of 'placelessness' (Kohler 2008: 766). And, as Kohler (2008: 766) has noted, '[p]lacelessness marks lab-made facts as true not just to their local makers but to everyone, anywhere. It marks the lab as a social form that travels and is easy to adopt, because it seems rooted in no particular cultural soil but, rather, in a universal modernity'. We will see something of the special mobility afforded to the laboratory produced housing facts of the Building Research Station, as opposed to field produced facts, in what follows.

Knorr-Cetina, like other sociologists and historians of laboratory science, also acknowledges that there are variations in the social and spatial configuration of laboratories. This includes the 'family resemblances' that occur between laboratories and other physical and virtual spaces of knowledge production such as clinics, theatres, lecture rooms, farms and field stations. As we have noted in our opening, another variant of housing science at this time was the application of social science to post-occupancy evaluations, especially of the 'experimental' high-rise typology. This science was conducted in the field and, as the scholarship on field-based science has shown, operated on different premises to that of the laboratory experiment (Latour, 1999). Robert Kohler, writing about the natural sciences, has provided additional complexity to the distinction between what he calls labscapes and landscapes. He has noted, for example the ways in which field scientists often simplified their field reality in order to produce lablike experiments, or found their complexity-dependent, field based findings unable to garner the credibility or transferability they may have desired because of their unavoidable place specificity. Such scientists, as with social scientists studying the lives lived in already built high-rise houses, were inevitably engaged in a scientific practice of place. But while natural scientists might seek to re-order the field such that it produces methods of accessing data that are laboratory-like, in the sociology of housing there was a desire to let the field-site speak in all its complexity.

Our entry point into this discussion is the 1961 government-sponsored report by Parker Morris entitled *Homes for Today and Tomorrow*, which set down desired standards for

post-war building, including housing. We then move out from this report to examine two kinds of experimental spaces. The first is the building science laboratory spaces of Britain's Building Research Station in Garston. This research station and its laboratories predated the production of the Parker Morris Report, and many of the facts produced by the experiments conducted there underscored the Parker Morris standards. The second is a post-occupancy field study of high-rise housing in Glasgow undertaken by Pearl Jephcott (1900-1980) and published in 1971 under the title *Homes in High Flats: some of the human problems involved in multi-storey housing*. Using a range of recently completed and occupied public high-rise housing estates in Glasgow this study sought to ascertain user satisfaction with the 'experimental' high-rise housing type. We show that such published reports on architectural standards and performances are part of wider actor-networks (Law, 1992; Latour, 2005). We demonstrate how the scientific practice associated with such reports entails observed objects (such as lifts, or windows, or air currents) being linked to certain other objects but not to others; and how these different associations work to make visible the relations between architecture other objects such as researchers, users and institutions. Such linking work is, we argue, central not only to the practice of fact making evidenced in such reports, but also for the way that the facts reported upon contribute to the making and stabilization of specific architectural design solutions for mass housing. The stable facts that they produce work variously. Sometimes they allow a specific design to materialize as built architecture and reproduce itself. Other times, the facts may work to weaken a specific design proposition and even prevent it from replicating itself. We will complement our existing argument by looking at how the building facts (be they design standards or user evaluations) that are inscribed in such reports, and come to be distributed by them, are produced in and through messy scientific work in which the will to laboratorize is strong, but the laboratories that were really built were rather weak.

Tomorrow's housing

The new mood of design science in Britain was given expression in the 1961 publication *Homes for Today and Tomorrow*, otherwise referred to as the 'Parker Morris Report'. Authored by the then Department of the Environment's Central Housing Advisory Committee the Report laid out revised national (actually English and Welsh) 'standards of design and equipment applicable to family dwellings' (Ministry of Housing and Local Government, 1961: iv), thereby upgrading standards produced in 1944 by the Dudley Committee. The nation was experiencing new levels of demand for housing because of increasing household formation, slum clearance and urban renewal. It was also experiencing a new 'patterns of living', an aspirational demand for housing with more up-to-date standards in floor space, able to accommodate appliances such as refrigerators and washing machines, and more suited to flexible uses of rooms and with adequate circulation and storage space. The report was illustrated by the architect Gordon Cullen, and the opening image (Figure 1) of the report communicates in a stylised fashion two of the key objects of scientific investigation of the housing research associated with the report: one being internal flows (of air, heat), the other being humans (their levels of satisfaction and behaviours).

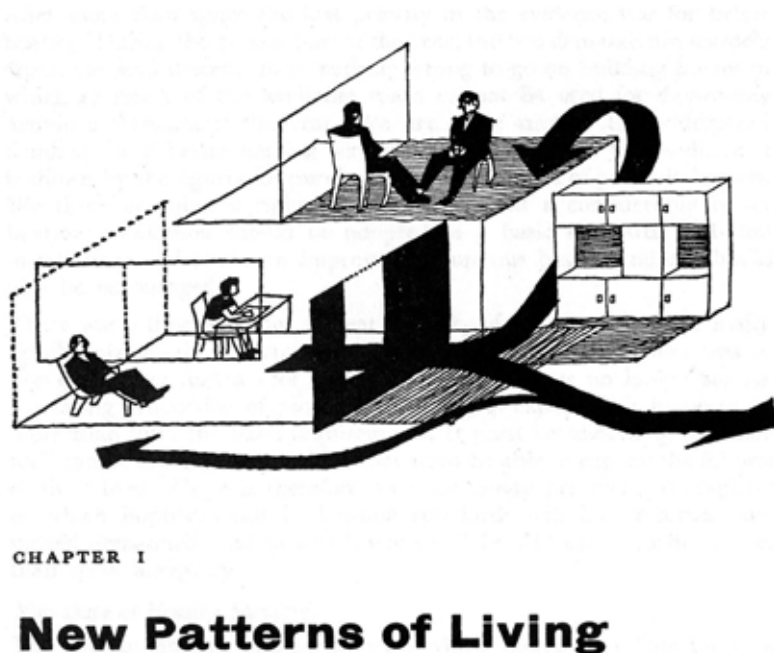


Figure 1: The Parker Morris report's stylisation of building standards around flow and folk (Ministry of Housing and Local Government, 1961: 1)

Among other things, the betterment of housing through attention to flow and folk is what the standards laid out in the Parker Morris report seek to produce. The illustration

presents these two objects as if already well accommodated and understood dimensions of the housing of the future. And of course the report, which is directed at all involved in housing provision and construction, operates as a dissemination devise for these newly agreed upon standards. But where did these standards come from and where were they heading? The Report was not based on science conducted by the authoring Committee itself or its agents. Meeting some 24 times and making numerous field visits, the Committee essentially synthesised existing evidence in written and oral form from some 80 bodies, including the Building Research Station. The Parker Morris Report, and the standards it specified, can be understood as a *black box* which appears to express a strong and stabilized attachment between building standards, design practice and scientific facts produced elsewhere. Through building standards guidelines like those laid out in the Parker Morris report, architectural design is 'made into an automaton' which 'act[s] as one' with the science that surrounds it (Latour, 1987: 132). In reports such as Parker Morris the intermediary relations that mediate between the world and language (crystallized in the stylised drawing of modern living) are obliterated (Latour, 1993a). In what follows we wish to trace some of these experimental intermediaries. In the first instance we do this by entering into the laboratories of the building science that preceded the setting of standards, specifically with respect to home heating science conducted at the Building Research Station. The provision of 'better heating' (Ministry of Housing and Local Government, 1961: 15) was considered to be central to the revision of housing standards for it ensured maximum (and more flexible) use of provided floor space, halting the winter phenomenon of household members huddling around a single fireplace in the sitting room. In the second instance we do this by entering into the post-occupancy social science conducted on the high-rise, a housing type considered to be 'experimental'. That science took as axiomatic that housing research should attend to what they called 'flat life' and residents' levels of satisfaction with it (Ministry of Housing and Local Government, 1961: 28).

Laboratories of housing atmosphere

The Building Research Station (hereafter BRS) was established in 1921, first in West Acton and then in Garston, and was the first scientific institution of its kind in the world. Its research both met the growing appetite among architects for scientific knowledge, and sought to replace the 'trial and error' craft traditions of the building trade with a systematic application of science to building concerns (Lea 1971). The BRS, then, replaced one kind of experiment with another. As Lea (1971: 1) noted, with traditional architectural design and building practices 'every novel structure or jump in construction was an experiment, and many failed'. Real world, real time experimentation (and all the risks and costs it carried with it) was replaced with a more controlled experimental order sequenced prior to, and away from, the acts of design and building. The BRS also saw itself as offering a crucial role in mobilizing knowledge. Firstly, it sought to bridge the gap between pure science and applied science. While in universities relevant research in chemistry, physics and structural mechanics 'flourished' and were 'rapidly advancing' thinking about the relevance to building 'had no place'. As Groak (1992: 4) noted, '[d]esigners and constructors complain that this information is only available in forms which...are ... indigestible for everyday use'. Furthermore, and this is where we begin to glimpse something of the significance of the experimental space offered by the BRS, this pure science had nothing to say to the pressing applied matter of the 'functions of buildings as a whole' (Lea, 1971: 4). So the second mobility the BRS tried to effect was between its applied science and the actual building industry.

The aim of experimenting through the 'building as a whole' came to structure the ways in which the BRS developed, and this is indicated in the research done on house heating and ventilation. By 1926, for example, an experimental house with a structural frame with walls that could be replaced by different kinds of materials had been built at Garston so as to develop adequate measurement systems for heat transmission. By 1931 this original 'experimental house' was deemed insufficient for the study of heating systems and a proposal was made to construct a 'controlled weather house' which was completed in 1936 (Lea, 1971: 65). This was a full-sized room within a larger outer structure, which enabled experiments to be conducted in which both internal temperatures and external temperatures were regulated. Another example, comprised a full sized room within a larger structure, what heat transmission of buildings under natural conditions of exposure to weather (Lea, 1971: 63). By the mid-Twentieth century the BRS's interest in 'whole building' experimentation with regard to heating and ventilation was given a new impetus. The 1945 Post-War Building Study Committee on Heating and Ventilation of Dwellings emphasised the need for comparative information on the performance of domestic heating systems under 'normal operating conditions' (Lea, 1971: 113). In 1946 construction was started on a site at nearby Abbots Langley of a group of some 20 semi-detached houses with different methods

of space and water heating, from open fires to whole-house central heating. These came to known as the Abbots Langley 'experimental houses' (Figure 2). Soon after, four more houses were built to study the interaction of the house plan and the heating systems, and a further 12 for investigating the influence of the thermal capacity of the house structure on heating requirements (Lea, 1971: 113).

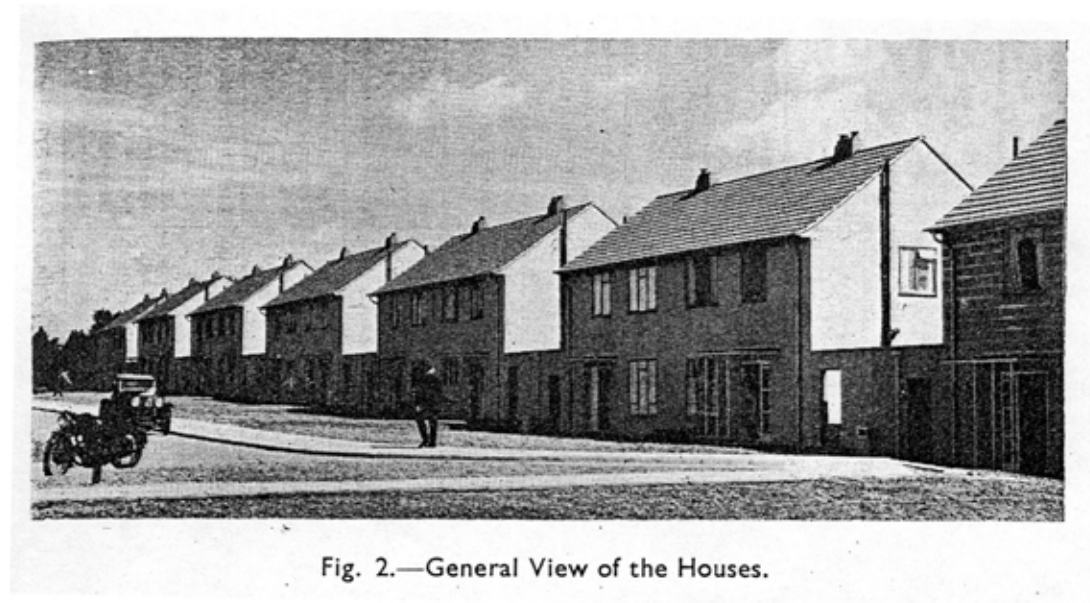


Figure 2: The Abbots Langley trial houses (Weston, 1949: 237)

The Abbots Langley houses were, quite literally, both homes and laboratories. The Building Research Station historian and former Director of the BRS Frederick Leas (1971: 113) recalls the experiments conducted in the home laboratories:

‘These houses were kept unoccupied during the winter of 1946-47 with the same thermal routine maintained in all and the fuel consumption and the rates of ventilation measured. This gave comparative results uninfluenced by the habits of occupants. The houses were then let to applicants from the local authority housing list and measurements continued over three succeeding winters. Each year the tenants were moved from one house to another, a somewhat delicate operation, so that by 1952 results became available with several different tenants for each heating system.’

Ventilation at this time was the great unknown in heating research. Whilst, for example, heat transmission through walls was a well-researched domain, heat loss through internal air movement was an unknown variable. In what follows we try to provide an insight in the reorganisation of attachments that occurs through these experiments. We do so

by concentrating on a chain of translations (Latour 1993b) through which heterogeneous elements are newly attached. It is our argument that these new arrangements and attachments work to put a new architectural order in place. In this sense we consider the Building Research Station as a site where objects such as air, ventilation, warmth, comfort or open plan living 'live a clearly multiple and complex life' (Latour, 2005: 80). What appears as an *automaton* or a *black boxed* standard in the Parker Morris report was, 25 years earlier at the Building Research Station and its laboratories, an open field in which atmospheric details, measuring instruments, people, walls and rooms are not, as Latour puts it, 'right in place'. In the remainder of this section we investigate this open field by way of a more detailed account of the ventilation experiments conducted in the Abbots Langley experimental houses. The 'full-scale trials on house heating' were experiments that accomplished a necessary spatial, temporal and social re-ordering of housing features (walls, layouts, materials) and natural features (temperature, air, circulation). The results of these experimental reorderings were firstly inscribed in plans, lists, charts and graphics and secondly translated into a new material geography of 'modern' homes.

Translation No 1: The Order of the Experiment

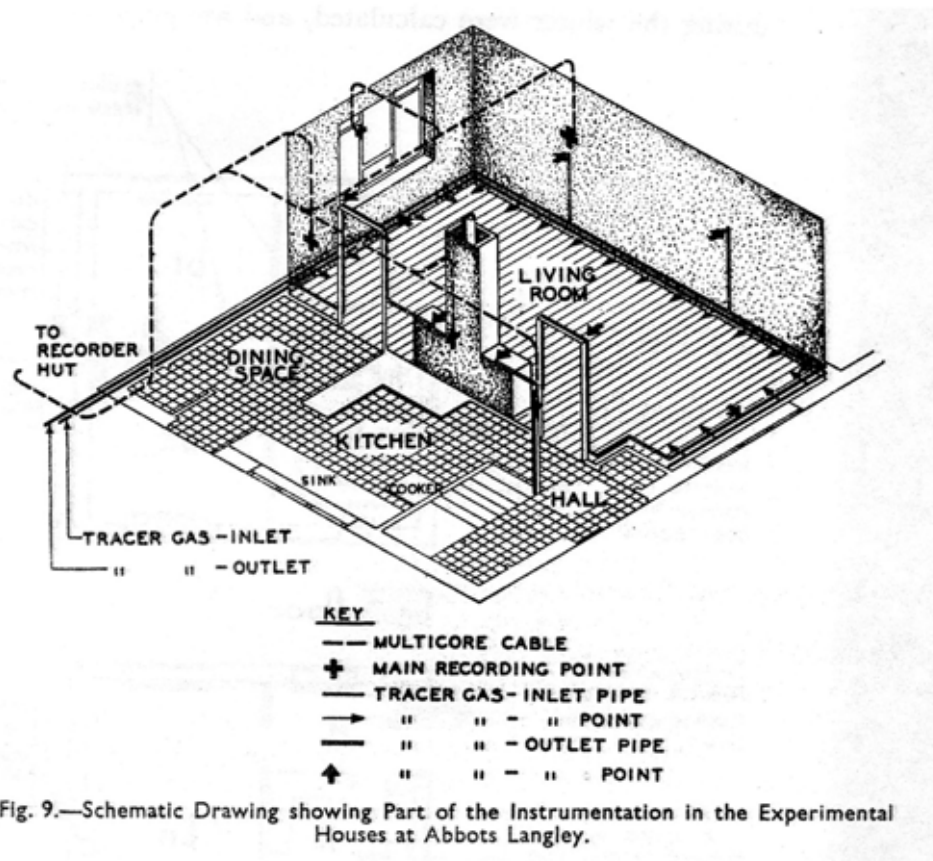


Figure 3: Instrumentation in the experimental houses at Abbots Langley (Pickels, 1949: 79)

Measuring ventilation is in effect about measuring and tracking air movement, and took place in these experiments by way of a technique that used tracer gases (Figure 3). A copper-tube enabled helium to be introduced into the rooms. The composition of air was sampled in various parts of the house at various times and the subsequent decay in the intensity of the helium measured. During times when the houses were occupied, this tracer gas experiment could be guided from outside the houses without disturbing those in residence (Pickels, 1949: 79). During times when the houses were unoccupied, this technique measured flow with doors and windows shut constantly, establishing a pre-occupation base line. In experiments during which the houses were occupied, an observer recorded every window opening and closing during the monitored heating season. Airflows from one to the next room cannot be measured as such. What was measured, however, was how much air an individual room was losing or gaining per hour.

Translation No 2: Centralising Data and Inscribing Tables



Figure 4: Central recording device used in heating experiments at the BRS

Table IV.

	B1	B2	B3	Hall	L. R.	K.	Bath
Volume (cu. ft.) of room ..	1025	920	520	1080	2035	1090	375
Standard air supply (cu. ft. per hr.)(recommended in Egerton Report)	1200	1200	600	—	2400	1000	—
Equivalent air changes per hr.	1.17	1.30	1.16	1.00	1.18	0.92	2.00
Average air changes per hr. Type I	2.4	2.8	1.2	2.3	2.9	3.3	1.9
Difference from standard ..	+1.2	+1.5	0	+1.3	+1.7	+2.4	-0.1
Average air changes per hr. Type II	2.0	2.5	3.1	4.3	2.6	3.5	4.3
Difference from standard ..	+0.8	+1.2	+1.9	+3.3	+1.4	+2.6	+2.3
Average air changes per hr. Type III	As house Type II				2.7	As house Type II	
Difference from standard ..					+1.5		

Type I. House with solid-fuel flue in living room.

Type II. Centrally-heated house, with solid-fuel flue in kitchen.

Type III. House with solid-fuel flues in kitchen and living room.

April

77

1949

Figure 5: Table performing average air changes per hour (Pickels, 1949: 77)

Centralized recordings produced by scientist and machine working in unison (Figure 4) were translated into tables, which, in turn, translated the experimental space into a form (on paper) that could circulate and potentially be applied to houses beyond the site of experimentation (Figure 5). In the table, each room is translated into a column distinguished from each other only by 'volume'. This translation blurs any distinction between rooms that may arise due to their design, their furniture or the presence of a 'user' and their actions. The table translation also, of course, elides the scientific instruments and practices necessary to its production.

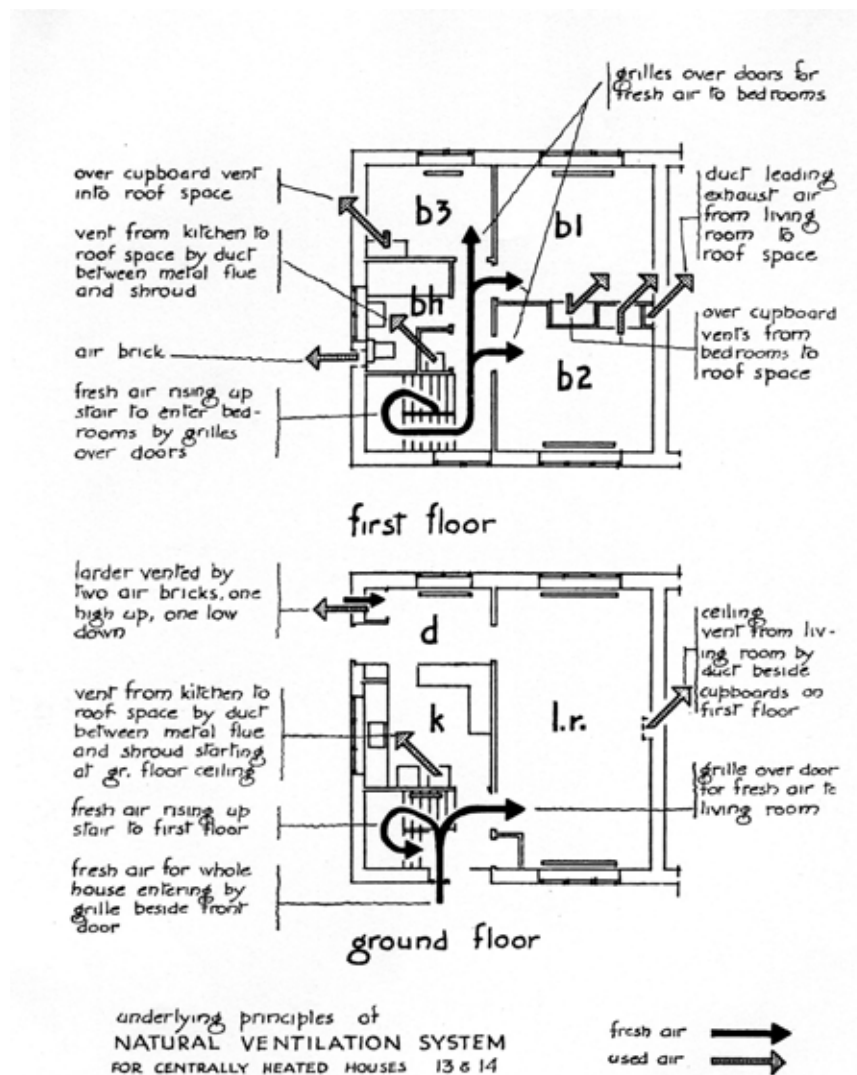


Figure 6: The so-called 'Natural Ventilation System' (Eve and Weston, 1948)

Visual drawings like the one in Figure 6 **above** show how quantified (and tabulated) air changes are, in a subsequent stage of integrating science into architecture, re-inscribed into a plan drawing of the existing experimental houses as a series of arrows. In this translation the rooms move from being abstracted 'volumes' and are reconnected to various apertures – notably, windows, doors and ventilation grilles – no doubt deemed significant shapers of the facts of air circulation and ventilation.

Translation No 4: New experimental houses

In the final translation (Figure 7) we see another house plan with arrows. This is not a diagnostic diagram, but a plan of an experimental house with a ventilation system that has been designed incorporating the preceding scientific diagnostics of air movement in houses. This is a plan of the house scientific building design makes.

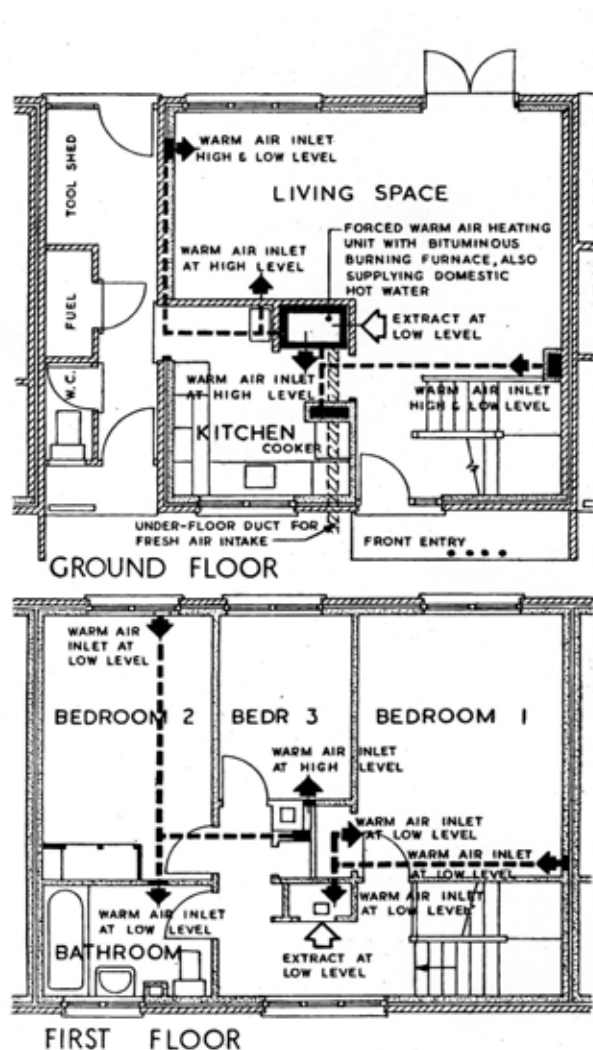


Figure 7: Additional experimental houses at Abbots Langley (unknown, 1949: 360)

One of the concerns expressed in the Parker Morris report was that existing floor plan standards were inflexible and too tied to pre-scripted room use. One of their objectives in altering how floor space standards were expressed was to create freedom in terms of the design of internal home layouts: they wanted to create houses with internal spaces that were 'not about rooms so much as the activities people want to pursue in their homes' (Ministry of Housing and Local Government, 1961: 4) Underscoring such ideas was a new sense of the

possibility of 'open plan' living if the issue of internal thermal comfort could be managed. The BRS had already begun to produce the needed data for this design aspiration. Four terrace houses were built in Abbots Langley in 1948 which had no wall between what conventionally would have been the living and the dining room spaces (unknown, 1949). Through these experimental homes an emergent design idea was tested for its impact on ventilation and atmospherics comfort. The ability of the Building Research Station to evaluate open plan design is already, through their existing scientific research, an established 'fact'. Now they are able to garner that expertise to not only to speak on behalf of a new material order, but to intervene in – to help design – a new architecture.

Let us return then to the illustration used to open the Parker Morris report and its stylized depiction of a house of flows and folk (see figure 1). The arrows in this image carry with them the objectives and facts of the applied science on heating and ventilation conducted in the decades before in the house laboratories of the Building Research Station. In these laboratory houses, the tenants, scientists, heating systems, apertures, air flows and measuring instruments 'were all tied together in order to transform the whole [house] into a smoothly running [or shall we say ventilating] automaton' (Latour, 1987: 130). It is this model of an automated housing science-architecture, which is diffused through the Parker Morris report. Of course in the Parker Morris illustration any trace of the (scientific) attachments that enabled 'the efficiency, efficacy, elegance and functionality' of modernist housing architecture to materialise, have been 'rejected, externalized and ignored' (Latour, 2004). In short, the building science *laboratorization work* that operated to produce the standards, technologies and designs of a post-war domestic architecture has 'receded into the background' (Latour, 2005: 81). The arrows have become *representative* of 'modern' ideas of society, architecture and space design.

Laboratories of high-rise experimentation

The Parker Morris report established standards for all housing typologies, but throughout the report there is a sense that the emergence of high-rise flats created new imperatives for the revision of housing standards. Motivated by an 'appreciation of the special needs of those who live on high density estates' (Ministry of Housing and Local Government, 1961: 28) and a desire to replicate in high-rise housing the design standards of more traditional low-rise housing types, the report devoted a separate section to the high-rise. Yet the report is clear about its limitations with respect to the high-rise typology. For example, in relation to heating standards, the report confines its attention to conventional 2-storey housing 'because the heating of dwellings in multi-storey buildings raises complex technical questions' (Ministry of Housing and Local Government, 1961: 27). Similarly, with the issue of resident needs in high-rises, the report admits that it 'makes no more than a beginning' (Ministry of Housing and Local Government, 1961: 28). It is in this absence of specification that we glimpse something of a confirmation of the populist view that high-rise housing was indeed 'experimental'. At the very least, in relation to the objects of heating and users there was an acknowledged gap between the kind of laboratory-linked scientific facts produced by the Building Research Station and actual high-rise housing. So while a key objective of the Parker Morris Report was to ensure that housing design 'satisf[ies] the requirements of families likely to live in them' (Ministry of Housing and Local Government, 1961: 4) by reorienting standards towards 'needs as a whole of the intended occupant', the extent to which those needs and requirements were met by high-rise housing remained an open question. Indeed, some 8 years after the Parker Morris report was published Raymond Studer (1969: 59) in a volume dedicated to architectural design method lamented that the 'data is simply not in' on the 'wholes' that are the large and complex 'behavioural continuums' of architecture.

In the previous section we charted how the Building Research Station bridged the gap between isolated, university based pure science that had 'no place' for the concerns of the building industry by constructing a sequence of house laboratories that enabled them to say something about the house 'as a whole', and to say it through the distributing format of the housing standard. The house laboratory pushes away from the typical view of the laboratory deliberately built as placeless place. It sought to be in place, to be exposed to variable (if measurable) weather conditions and to accommodate the unpredictable behaviour of residents. From the point of view of the desire to understand something of satisfaction with the high-rise experiment, such hybrid-laboratories were simply not 'whole' or 'in place' enough. As we shall see in the wake of the Parker Morris report there was a spate of social scientific, field-based, post-occupancy studies that sought to better understand the 'total residential environment' and particularly as they pertained to the high-rises (Goodchild and Furbey, 1986; 84; Hayden, 1984; Forty, 2000). Such housing complexes were

viewed at least by some social scientific eyes as 'unparalleled near-experimental setting' (Merton 1951: 185-186) which, unlike the laboratory experiment, were not 'artificially impoverished' (Studer, 1969: 59). In this section we turn our attention to just one example of the broader post-occupancy scholarship on high-rise housing that was being undertaken in Britain across the course of the 1960s to the 1980s (see as examples only Darke and Darke, 1970; Cooper, 1972; Gittus, 1976; Coleman, 1984). This research was sometimes conducted by university based academics, and sometimes by scholars working in consultancy arrangements with government departments. The cumulative goal of the research was to establish the facts about what it was like to live in a high-rise housing, understood by all to be so novel in style and layout to be 'experimental' relative to pre-existing housing architecture conventions. As Dunleavy (1981: 141) notes, the high-rise was, from the outset, surrounded by debate, and the 'final contribution' was offered by sociologists. He depicts a high-rise delivery network that has sociologists and their 'social' facts as active in the 'collective design' of the high-rise experiment, although as we shall see their science had a different geographical and temporal relationship to built homes than that of the Building Research Station. 'The newly prominent social responsibility themes in architectural ideology' he points out 'meant that the design professions were unusually responsive to their arguments and findings' (1981: 141). Indeed, in 1957 (even prior to the extensive commitment among British local authorities to high-rise housing), there was a high profile public exchange in *The Times*' letters to the editor between expert sociologists debating the social pros and cons of high-rise housing. This 'fragmentation of sociological opinion', as Dunleavy (1981: 143) called it, sustained itself until the 1960s when 'research explicitly directed towards the social dimensions of high-flat living got under way... [and]...the profession slowly came round to better founded and generally more critical appraisal of the implications of the high-rise boom'.

Nearly all the social science and post-occupancy studies of this time derive their data gathering techniques from standard sociological research methodologies, such as the questionnaire survey or the interview and, on occasions, observational data. Central to these post-occupancy surveys is siting these data collection exchanges between researcher and researched in the setting of the high-rise itself: questionnaires might be posted to respondent's home in the mail, or respondent views accessed by way of an interview conducted in the home. Through such data gathering moments residents would be asked if they were satisfied with their homes, and which aspects they liked or disliked. Standing as it does in the positivist tradition of sociological research, such post-occupancy research positioned the building itself as an 'external' feature of the interview situation. For example, texts of the time on good practice sociological methods promoted the interview as the 'mechanical instrument of data collection' and advised researchers to establish conditions for interviews such that external interference would be minimized so that the interviewees would act as passive individuals fully enmeshed in the agenda of the social scientist (see

Hoong Sin, 2003). This structure of course resonates with the re-orderings of the object of analysis and the world that happen in and through the de-placing and re-locating logics of the laboratory. For post-occupancy sociology then interviews taking place in homes of residents are potentially problematic and have to be strategically planned, so that, for example, the interview conversation would not be disturbed by what is present or happening in the home during the interview encounter. The methodological matter that post-occupancy studies struggled with was how to bring such laboratory logics into the site of the field. Was it possible, and for that matter was it even desirable, to rigorously separate the place of investigation (the home of the resident where the interview takes place) from the object investigated (resident satisfaction)?

In what follows we wish to focus on just one such study: that being the study conducted by historian-turned-social-scientist, Pearl Jephcott, and published in her 1971 book *Homes in High Flats: Some of the Human Problems Involved in Multi-storey Housing* (Figure 8). That study shows well the difficulty social scientists faced when working in the high-rise, as well as the consequences of this difficulty for the facts that they produced. In our analysis of this study, as reported in the published findings, we try once more to follow the reorganisation of attachments between the components of the experimental field in the quest to produce knowable and transferrable facts, in this instance about high-rise living. Our focus is on how successfully the place of investigation can be distanced from the object of investigation. Unlike the building science of the BRS, where we were able to access a chain of connected translations, in this account of social science we draw attention to punctuating attempts within the published report where Jephcott seeks to properly assemble her findings in order to produce laboratory-like effects. The report reveals how Jephcott tried to establish laboratory-like conditions in her field site, but ultimately struggled to establish or sustain such an order. That this is the case is perhaps not surprising. It is not simply that Jephcott was dealing with the novel complexity of lived-in high-rise housing, she was also a scholar whose intellectual sensibilities were more humanistic than scientific. That this is the case is perhaps evident in the opening pages of her published findings which is not only illustrated with an expressionist style painting of a high-rise, but carries the specification: 'People and their homes rather than housing in the usual sense of the word are the subject of this study' (1). What is remarkable about Jephcott is that in her report we find something of the will to laboratorize the high-rise and the difficulties she had in doing so. However, while observing the failure to distance the place of investigation (the high-rise) from the object of investigation (resident satisfaction), we also observe the emergence of a novel and more heterogeneous housing sociology in which the place of investigation and the object of investigation are productively linked to each other.

Translation No 1: Setting up Glasgow as a laboratory of high-rise living

A researcher at the Department of Social and Economic research at the University of Glasgow, Jephcott's study sought to report on 'the human problems involved in multi-storey housing'. It was one of the first British attempts to deliver, as it is said in its foreword, a real study and knowledge' of the 'problems of living in high flats'. From the outset Jephcott both wanted to deliver a picture of those problems 'in a practical sense' (as it really was in all its complexity) and 'produce knowledge on high-rise living as a generic phenomenon' (Jephcott, 1971: v). Throughout her study we see her struggling to produce findings that had 'global' relevance, and doing so by way of a weak comparative method in which the instance of Glasgow was privileged through a more in-depth study.

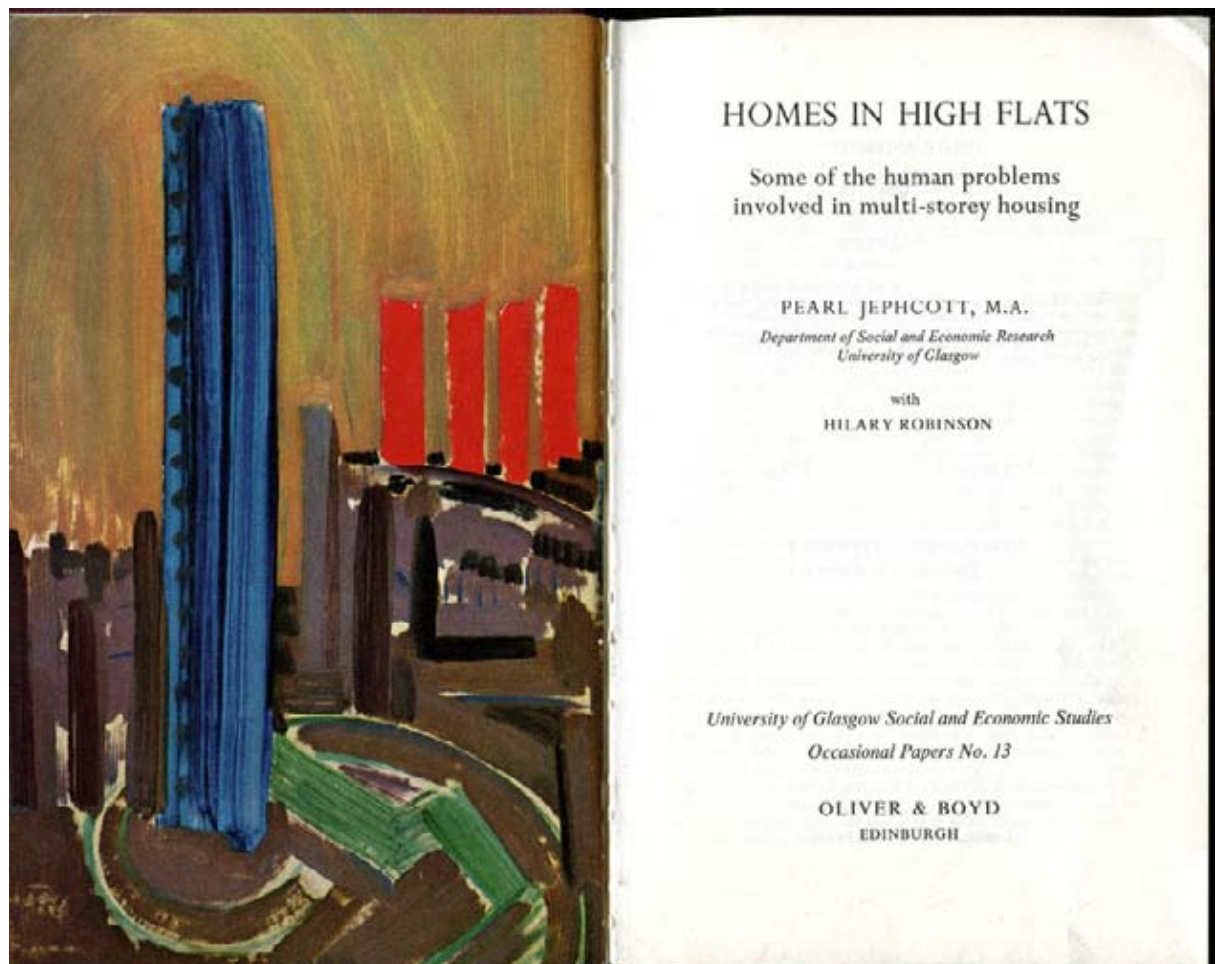


Figure 8: Title page and frontispiece of *Homes in High Flats* (1971)

Jephcott's science was from the outset set within an expectation that she would report comparatively on the real world of high-rise housing conditions. It was funded through

Britain's Joseph Rowntree Foundation a charity that had long supported quality research into the housing conditions of the poor. When commissioning Jephcott to undertake her study the Foundation 'left the terms of reference fairly open' but stipulated that the study should not overly focus on architectural design and that the Glasgow study should draw on 'a certain amount of first hand information obtained from examples of multi-storey housing in other parts of Britain and Western Europe' (Jephcott, 1971: 2). In order to meet this requirement Jephcott's study used secondary data that was collected on or about high-rise estates in London, Sheffield, Liverpool, Zürich, Berne, Stockholm and Utrecht, and combined it with her more detailed case study of Glasgow. In this comparative framework, Glasgow was positioned as the 'laboratory' of high-rise living which, through the connecting work of comparison, stood side-by-side with other cities as repeated phenomena (Figure 9). Although there is little systematic discussion of this comparative frame and what it meant for her findings Jephcott does note that she attempted to find data on these other places that replicated the 'topics...chosen for intensive work in Glasgow' (Jephcott, 1971: 34).

APPENDIX A
Basic information on examples of multi-storey housing visited in areas other than Glasgow. 1968.¹

City	London		Sheffield		Liverpool	Zurich	Berne	Stockholm	Utrecht
Estate	Brandon (G.L.C.)	Winstanley (Wandsworth Borough)	Park Hill and Hyde Park	Norfolk Park	William Henry Street	Lochergut	Tscharngut	Bredang I, II	Overvecht I, II
Dwellings	2,417	800	2,300	3,000	1,000	350	1,700 ²	3,800	8,800
Population	8,100	3,200	6,000	7,500	5,000	900	5,500	13,000 (Bredang I)	31,000
Multi-storey blocks	39	4	(horizontal street deck system)	15	6	1 (different heights)	13	14	35
Multi-storey dwellings	1,601	230	2,160	1,900	400	350	1,167	1,075	4,000
Multi-storey population	5,900	900	5,400	4,200	1,300	900	4,881	3,215	13,800

¹ In Britain as provided by the local authority. Abroad as provided by the local authority and/or other agencies.
² Includes figures for students and disabled persons.
All figures approximate.

Figure 9: Table from Jephcott (1971: 151) in which the Facts of Glasgow are put into a relationship with fact from other cities.

One of the problems that Jephcott's study faced, given the expectation of her funders for a comparative perspective, was establishing a scientific justification for the suitability of Glasgow as the in-depth case study 'laboratory' for understanding 'high-rise living' more generally. How transferable would the findings of the Glasgow study be? 'The city' she asserted 'has introduced high flats on an extensive scale and in many cases has built tower

blocks that are exceptionally tall' (Jephcott, 1971: 10). This necessary requirement of measurable and extreme instances of high living was, nonetheless, compromised by another local fact Jephcott had to admit early in the study: that Glaswegians had experience of living in multi-storey housing (walk-up tenements) and might not, because of this previous experience, have 'typical' reactions to high-rise housing (Jephcott, 1971: 10). This implied that Glasgow as a lived high-rise field site lacked an important control variable in terms of determining in any controlled way 'human problems of living in high flats', that being no previous exposure to similar modes of living. In short, Jephcott implied that her Glaswegian subjects either may have already cultivated certain adaptations to multi-storey living, or already be exhibiting negative effects. Given that part of the study was built around soliciting information that would 'establish more exactly any changes to their life that the tenants themselves ascribed to this new form of home' (Jephcott, 1971: 26), this was a worry that substantially qualified the facts produced about problems associated with high-living. This same tension is returned to later in the report where Jephcott admits that while the 'extent' of high-rise housing in the city makes Glasgow 'a useful setting in which to look at their social implications', 'it is very possible that certain features of the Glasgow situation may invalidate generalization' (Jephcott, 1971: 22). As Gieryn (2002: 5) has noted with respect to science, part of its work is to de-locate its inevitably situated scientific practice in order to produce credible truths. When scientific claims cannot engage in this de-location their credibility is diminished because their 'truthfulness depended upon conditions located only there'. This he calls the paradox of place and truth.

Further trouble for Jephcott's science was produced by the fact her study was conducted amidst the very construction process of the housing she sought to evaluate. One of the assumptions in a laboratory space is that the space for the experiment is stabilized, such that there is no interference from the laboratory itself. But during the course of one year of Jephcott's study the number of high-rise dwellings in Glasgow doubled from just over 7,732 in February 1967 to 14,658 homes in July 1968. Many of the estates she visited were unoccupied or only recently so: '[a]nother problem [of the study] concerned the setting up of control groups. Large numbers of the population on the estates were so new that they had to be excluded when investigating any subject where the length of experience of multi-storey life was judged to be essential' (Jephcott, 1971: 36). Again local contingency enters in to the science of the field site and prevents the stabilization of the kinds of conditions possible in a laboratory study. Indeed, it would seem that the very laboratory in which Jephcott wishes to work is under construction and anything but a stable container for scientifically devised intervention and experimentation.

Translation No 2: From what people say about to what people do in high-rise buildings

According to Jephcott's reasoning, because Glasgow builds more and higher high-rise houses than elsewhere the social implications of living in high flats are likely to be more clearly observable, making it a suitable study space. Regardless of this assumed experimental advantage, the complex *wholeness* of high-rise living still needed to be handled in such a way that Jephcott could gather systematic and comparable information. Just as the BRS scientists had to build their house laboratories to measure how ventilation operated in 'whole buildings', Jephcott has now to re-build the high-rise houses she selects as her field sites in order that she can collect 'facts relevant to social issues' (26). In her three year study of the Glasgow case study Jephcott adopted various data gathering methods. Central to the 'laboratory' that Jephcott creates is the interview between the researcher and the residents of selected high-rise homes. Interviews were carried out on behalf of a tested interview schedule. In the study a number of 1056 interviews is given and declared as representing a 5% sample of the Glaswegian high-rise population. Jephcott had to be sure that her 'laboratory' housed the correct experiment: in other words the right kinds of interviewees had to be set along side the right kind of questions. Firstly, the interviewees had to be able to speak for the experience of high-rise living. Given that Jephcott found herself working in a context where high-rise construction was still happening, she had to be sure that her interviewees were not too new to the experience to report upon it accurately. Secondly, try as she might to stabilize the building variable of the high-rise as a laboratory container it kept entering in and interfering with the order of her science. For example, her participants lived in various sizes of flats causing concern over the comparability of the data gathered. As comparative social sciences such as anthropology have long admitted, place-based comparison is not always conducted with the aspiration of the replicability of events over time that is built into the placeless laboratory experiment. Faced with these shortcomings in the survey data, over the course of her study Jephcott moved closer to a contextualised and ethnographic style. Two of her researchers were even dispatched to live in case study high-rises for a number of months.

One important technique Jephcott adopted opened itself entirely to the variability of the field site: this was a method which compared architectural claims around the benefits of high-rise design against the experience of living with that design feature. In this sense Jephcott used her field-based study to do what a laboratory can never do: ground truth a fact claimed elsewhere and more abstractly in the design process. This is explicitly by way of a series of 'minor studies' that evaluated user satisfaction around a number of features of high-rise environments: Services and facilities, the lift, playgroup, graffiti, primary school population, the disabled (Jephcott, 1971: ix). The detailed studies included the research staff undertaking onsite observations of interactions between residents and their environs. In the study 'The lift', for example, a member of the research team carried out a detailed study of

'lift waiting times and failures' (Jephcott, 1971; 159) derived from direct observation and measurements of waiting in lift halls and on landings. Jephcott moves to such ethnographic methods to create additional spaces of data gathering that she feels better speaks for high-rise living. In the interview space *an occupant speaks about the building*. In the observation space Jephcott tries to access *what people actually do in buildings*. The interview and the observation space are, each in their own way, the social science equivalent of the building science laboratory. Each of these field 'laboratories' orders differently the high-rise building and the high-rise resident in relation to the production of facts about high-rise living. In the interview the building is the *controlled context* of investigation but in the observational study it serves as the *active variable*.

Translation No 3: From the laboratory field to the field of housing design

Other instances of Jephcott's shift from controlling the context of her study to using it as an active element are explicated in the methods section of her published findings. For example, the report selects its research subjects not thorough standardised selection procedures but through the developing research process. Access to various actors and key figures was only granted with progressing work:

The research staff's initial contacts with the blocks very soon indicated that the caretaker was a key figure, an impression which was sustained throughout the study. They supplemented their day-to-day contacts with caretakers by a formal interview with one of them at each of 14 estates. These were held towards the end of the study when a good deal of insight had been gained into the caretaker's role. The estates were selected as likely to have dissimilar problems ,from the caretaker's point of view. (Jephcott, 1971: 34)

Similarly, during visits and interviews with tenants Jephcott invented creative methods to record the disjuncture between the design claims around high-rise living and its lived reality. For example in Figure 10 we are introduced to the window and the view of 'Mrs... of Wyndford'. Careless design meant that while the window captured a view, this view could only be seen from an impossible point near to the ceiling. A seated 'Mrs..., of Wyndford' could not enjoy the view at all for it was blocked by a poorly placed eye level balustrade. To describe such relations, the study invented *ad hoc* techniques such as the presentation of sequentially organised photographs (Figure 10). In this kind of *ad hoc* methodological accomplishment (the researcher standing on a ladder and using a camera to ground truth a design claim) is generated in and through the interaction between the researcher and the interviewee but also the building which 'enters' into the scene in compelling ways. Stable facts are produced not in a laboratory but in a field situation in such a way that the high-rise itself acts as proof of what is wrong in high-rise design and living. We see in this instance of

social science a particular manifestation of what Gieryn (2002: 113) refers to as a 'truth spot'. Jephcott's study moves from methods that try to laboratorize her field of research, to research that opens up to the field. Ultimately, the ability of the Glasgow case study to operate as a 'laboratory' for assessing high-rise living depends upon her generating a 'place-saturated' science 'achieved through the geographic, architectural and rhetorical construction of a "truth-spot"'.

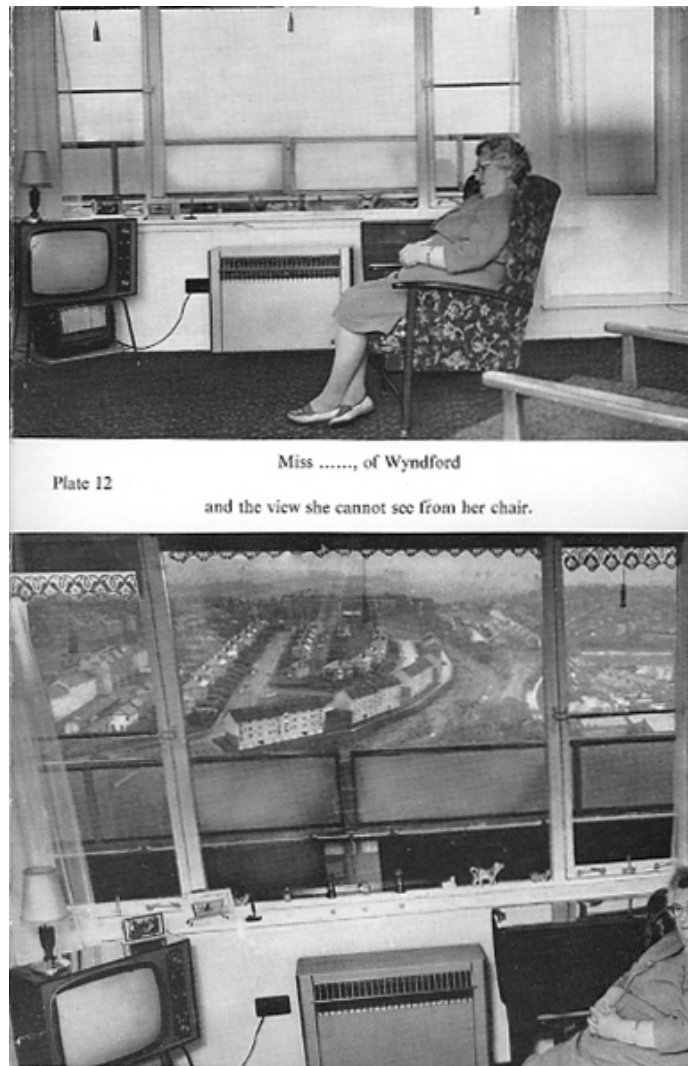


Figure 10. Mrs...of Wyndford and her truth spot window. (Jephcott, 1971: 104)

Translation No 4: Designing associations

How successful was Jephcott's attempt to make her Glasgow case study a plausible laboratory for understanding high-rise living more generally? How could her excessively place contingent knowledge operate as truth that travelled on in time and space to influence housing design and provision? Having set up her study enthusiastically and crafted as

convincingly as she possibly can networks of association that bolster her science and make Glasgow generalizable, it is the rhetorical power of her truth spotting that speaks most directly to the matter of the success or failure of high-rise provision. Her conclusion recommends that: 'local authorities should discontinue this form of housing except for a limited range of carefully selected tenants or in cases of extreme pressure' (Jephcott, 1971: 131).

We have seen how Jephcott comes to this conclusion through a science that struggled to stabilize its high-rise housing laboratory and keep the *place* of the study separated from the *object* investigated, ultimately giving way to a science saturated with place. As with the BRS which progressively brought the world and all its complexity in to the scene of its building science, so Jephcott progressively allows the wholeness of the high-rise complex to enter into her research. Opening to that complexity enabled her to confirm once more that the high-rise was indeed a failed housing experiment. But it also compelled her to ponder: 'What action should be taken about the high flats already built in Britain, the 380'000 homes with their million-odd population which are likely to be occupied for the next 60 years?' (Jephcott, 1971: 132).

What Jephcott has at hand with her place-saturated science is a powerful tool to turn to what she terms the 'non-social matters' of high-rise living, in short design and management standards. She gives clear advice on such matters as, for example: sizes and speeds of lifts (135); design of outdoor spaces (138); organisation of the view (139); alarm systems (139); the use of lift halls (144); sheltered seats at strategic points (144); communication between housing authority and tenants (146); and self-help strategies (148). These and other recommendations concern not merely the occupants nor merely the building. They focus on how buildings and people relate to each other. In the conclusion to her book Jephcott works hard to put to scientific use the manifold breaks she has witnessed between the design ideal and the reality of high-rise living. Her conclusion is anything but a summary of research findings. Rather she delivers a charter for on-going experimentation such that the high-rises already built may be better lived with. In this sense Jephcott's science gestures towards another meaning of experiment, the one that echoes creativity and productivity. Throughout the report on her research it is clear that she and her team innovated and experimented methodologically as they tried to accommodate the messiness of the Glasgow's high-rise 'laboratory' into their study. Jephcott uses the term experiment over 20 times in her report. Some of the time it is to confirm the sense of the high-rise as an architectural form that had insufficient scientific or craft experimentation to precede it. But most of the time it was to point to the fact that the shortfalls in high-rise living were generating an on-going compensatory field of experimentation: in servicing and maintenance, in resident-local authority communication, in lift, garbage and security removal technologies, and so on. In this sense, Jephcott's housing science uses the laboratory

of Glasgow to make recommendations for high-rises already built and for non-high-rise houses yet to come. The ordering of her science and its associated laboratories and experiments is in the logic of performance measurement and appraisal models being promoted by nearby colleagues at Strathclyde's Building Performance Research Unit. This unit, under the leadership of Thomas Markus, argued for a building appraisal science that reviewed existing buildings in order to make recommendations for future design work. Such appraisals were too late to make a foundational difference on the buildings studied, but their findings he argued could be 'generative' in relation to the next housing design problem. Such facts constituted not architectural design 'feedback' but 'feed-forward' (Markus, 1968: 111).

Jephcott's social science reveals to us the difficulty she faced in establishing Glasgow as a social scientific laboratory for the study of high-rise living. Her laboratory failed, for example, because she could not control the very size of her case study as Glasgow was at the time of her research still engaged in its 'crash drive' of high-rise construction (Glendinning and Muthesius 2004). It also failed when the tenant-researcher relationship could not stay contained in the controlled space of the interview and the building and all its problems literally 'entered' and 'disturbed' this interaction (Latour, 2000). Jephcott responds to these problems creatively, generating a range of *ac hoc* experimental methods such as observation studies of the buildings in use and interviews with caretakers. Jephcott reveals that the living project of high-rise housing supply, and the very force of the architectural objects she worked on and in, forces a social science in the making. Pearl Jephcott's merit was to give up neither her study nor the high-rise too easily. As a researcher she was courageous enough not only to build up laboratories but to enter the house of experiment.

Conclusion

This paper has sought to add historical and geographical specificity to the link between processes of laboratorization and experimentation and city building. We have done so by way of an analysis of the complex, sometime contradictory and sometimes failing laboratorization work that went on in the intersection between science, architectural design and housing provision in mid-Twentieth Century Britain. As noted, modernist architectural principles determined that there be a new intimacy between design and science, and we have charted in detail how this intimacy articulated itself in building science and housing social science.

In the case of building science conducted at the Building Research Station architectural artefacts (experimental houses) were produced then operated on in order to systematically expose how specific architectural layouts and configurations performed in relation to other materials (air, water and heat) in the production of acceptable building (or more specifically housing) standards. This science used house laboratories as experimental sites in the service of establishing housing facts that would travel to other houses and places by way of standards that aimed to reduce controversy. When viewed relationally like this, a governmental institution like the Building Research Station is not simply a pool of modern ideas for post-war housing construction, it is a centre of calculation, a very dense time-space convergence within a wider network, which was 'built to mobilise, cumulate and recombine the world' (Latour, 1987: 228). By contrast, post-occupancy housing science not only comes in the wake of building, but also, often enough, in the wake of controversies that have arisen as a result of the housing being occupied. This was nowhere more evident than in the case of high-rise mass housing where the novelty of this architectural experiment, and short-falls between political aspiration and delivery standards, generated a frenzy of sociological fact finding about the relationship between design and resident satisfaction. Through this science of the user it was hoped that housing design architecture might finally realize its potential.

Through these cases of housing science we have seen many variations of laboratories and many kinds of experimentation. The conventional definitions of laboratory as a placeless place for the conducting of experiments on objects abstracted from the real world fails to account for the variability evident in the related fields of applied building science, architectural design method and post-occupancy sociology. In this complex, multi-disciplinary field of housing science laboratory spaces, field sites and experimental objects are hybridized in various ways, and science which has at its heart an interest in stabilization finds itself shifting and innovating endlessly in the name of making standards for better housing. Our instance of mid-twentieth century innovation in laboratories and experiments marks just one narrow field of the endlessly experimental nature of the city. For example, our own research on high-rise living today has revealed a dispersed geography of everyday creativity, problem solving, experimentation and science in action, spread across fields as

diverse as tenants' meeting, planning departments, the studio of an architect or the workshop of the caretaker (Jacobs, Cairns and Strebel, 2007, 2010, 2012; Strebel, 2011). We hope that this paper has helped contribute something further to understanding the diverse ways that the concept and practices of 'laboratory' and 'experiment' operate as creative forces in city building.

Bibliography

- Baldwin, J. (1996) *Bucky Works: Buckminster Fuller's Ideas for Today*. Wiley, New York.
- Banham, R. (1960) *Theory and design in the first machine age*. Praeger, London.
- Broadbent, G. and A. Ward (1969) *Design Methods in Architecture*. Lund Humphries for the Architectural Association, London.
- Coleman, A. (1985) *Utopia on Trial: Vision and Reality in Planned Housing*. Shipman, London.
- Cooper, C. (1972) Resident dissatisfaction in multifamily housing. In W.M. Smith (Ed.) *Behavior, Design and Policy Aspects of Human Habitats*. University of Wisconsin: Green Bay. 119-146.
- Cowen, H.J. (1978) *Science and building: Structural and environmental design in the Nineteenth Centuries*. John Wiley & Sons, New York and London.
- Cross, N. (2001) Designerly ways of knowing: Design discipline versus design science, *Design Issues* 17 (3), 49-55.
- Courtney, R. Building Research Establishment – past, present and future, *Building Research and Information* 25 (5), 285-291.
- Darke, J. and R. Darke (1970) Health and Environment: High Flats *University Working Paper, 10*, Centre for Environmental Studies, London.
- Driver, F. (2000) Fieldwork in Geography, *Transactions of the Institute of British Geographers* NS 25, 267-268.
- Dunleavy, P. (1981) *The politics of mass housing in Britain, 1945-1975: A study of corporate power and professional influence in the welfare state*. Clarendon Press, Oxford.
- Eve, R. and Weston, J. C. (1948) The economics of house heating, *RIBA Journal* 56, 12-26.
- Forgan, S. (1989) The architecture of science and the idea of a university, *Studies in History and Philosophy of Science* 20, 405-434.
- Forty, A. (1999) 'Spatial mechanics': Scientific metaphors in architecture. In P. Galison. and E. Thompson (eds), *The Architecture of Science*. The MIT Press, Cambridge, Mass.
- Forty, A. (2000) *Words and Buildings: A Vocabulary of Modern Architecture*. Thames and Hudson, London.
- Frampton, K. (1996) *Studies in tectonic culture and modern architecture*. The MIT Press, Cambridge, Mass.
- Frampton, K. (1999) The mutual limits of architecture and science. In P. Galison. and E. Thompson (eds), *The Architecture of Science*. The MIT Press, Cambridge, Mass.

Galison, P. and E. Thompson (eds), *The Architecture of Science*. The MIT Press, Cambridge, Mass.

Giedion, S. (1995 (1928)) *Building in France, building in iron, building in ferroconcrete*. Getty Center for the History of Art and the Humanities, Santa Monica, CA

Gieryn, T.F. (2002a) What buildings do. *Theory and Society* 31, 35-74.

Gieryn, T.F. (2002b) Give place a chance: A reply to Gans, *City & Community* 1 (4), 341-344.

Gieryn, T.F. (2006) City as Truth-Spot: Laboratories and Field-Sites in Urban Studies. *Social Studies of Science* 36, 5-38.

Gittus, E. (1976) *Flats, Families and the Under-Fives*. Routledge Kegan and Paul, London.

Glendinning, M. and Muthesius, S. (1994) *Tower Block: Modern Public Housing in England, Scotland, Wales and Northern Ireland*, Yale University Press, New Haven, CT.

Goodchild, B. and R. Furbey (1986) Standards in housing design: A review of the main changes since the Parker Morris report (1961), *Land Development Studies* 3(2), 79-99.

Groak, S. (1992) The idea of building: Thought and action in the design and production of buildings. E & FN Spon, London.

Hall, P. (1988) *Cities of Tomorrow: An Intellectual History of Urban Planning and Design in the Twentieth Century*, Blackwell, Oxford.

Hanley, L. (2006) *Estates: An Intimate History*, Granta, London.

Hayden, D. (1984) *Redesigning the American Dream: The Future of Housing, Work and Family Life*. W.W. Norton and Company: New York, London.

Hester, S and Francis, D, (1994) Doing data: the local organization of a sociological interview, *British Journal of Sociology*, 45, 675-695.

Hoong Sin C. (2003) Interviewing in 'place': the socio-spatial construction of interview data. *Area* 35(3), 305-312.

Jacobs, J. M., Cairns, S. and Strebel, I. (2007) 'A tall story...but, a fact just the same': The Red Road highrise as a black box, *Urban Studies*, 44(3), 609-629.

Jacobs, J.M., Cairns, S. and Strebel, I. (2010) Materialising vision: Performing a high-rise view. In S. Daniels, D. DeLyser, J. Ketchum and D. Richardson, *Geography and the Humanities*, Routledge, London and New York.

Jacobs, J.M., Cairns, S. and Strebel, I. (2012) *Doing Building Work*, *Geographical Research*.

James, F.A.J.L. (1989) *The development of the laboratory: Essays on the place of experiment in industrial civilization*. Macmillan Press, London.

- Jephcott, P. (1971) *Homes in High Flats: Some of the Human Problems Involved in Multi-storey Housing*, Oliver & Boyd, Edinburgh.
- Knorr-Cetina, K. (1992) The couch, the cathedral and the laboratory: On the relationship between experiment and laboratory in science. In A. Pickering (ed.) *Science as Practice and Culture*. University of Chicago Press, Chicago.
- Knorr-Cetina, K. (2001) Laboratory Studies: Historical Perspectives. In *International Encyclopedia of the Social & Behavioral Sciences*, Elsevier, Amsterdam. 8232-8238.
- Kohler, R.E. (2002) *Landscapes and Labscapes: Exploring the Lab-Field Border in Biology*, University of Chicago Press, Chicago.
- Kohler, R.E. (2008) Lab History: Reflections, *Isis* 99 (4), 761-768.
- Kuklick, H. and R. Kohler (1996) *Science in the field*. Cornell University Press, Ithaca, New York
- Latour, B. and S. Woolgar (1979) *Laboratory life: The construction of scientific facts*. Princeton University Press, Princeton.
- Latour, B. (1983) Give me a laboratory and I will raise the world. In K. Knorr-Cetina and M. Mulkay (Eds) *Science Observed: Perspectives on the Social Studies of Science*, Sage, London. 141-170.
- Latour, B. (1987) *Science in Action: How to Follow Scientists and Engineers Through Society*, Open University Press, Milton Keynes.
- Latour, B. (1993a) Le 'pédofil' de Boa Vista - montage photo-philosophique. In *Petites leçons de sociologie des sciences*, Seuil, Paris. 171-225.
- Latour, B. (1993b) *Petites leçons de sociologie des sciences*, La Découverte, Paris.
- Latour, B. (1999) *Pandora's hope: essays on the reality of science studies*. Harvard University Press, Cambridge MA.
- Latour, B. (2000) When Things Strike Back: A Possible Contribution of Science Studies to the Social Sciences, *British Journal of Sociology* 51, 105-123.
- Latour, B. (2004) Is there a non-modern Style,
http://www.ensmp.fr/~latour/presse/presse_art/GB-01%20DOMUS%2001%2004.html
- Latour, B. (2005) *Reassembling the Social: An Introduction to Actor-Network-Theory*. University Press, Oxford.
- Law, J. (1992) Notes on the theory of the actor network: ordering, strategy and heterogeneity. In *On-Line Papers Centre for Science Studies Lancaster University*.

- Lea, F.M. (1971) *Science and building: A history of the Building Research Station*. Her Majesty's Stationary Office, London.
- Livingstone, D. (1995) The spaces of knowledge: contributions towards a historical geography of science, *Society and Space* 13, 5-34.
- Livingstone, D. (2000) Making Space for Science, *Erdkunde* 54(4), 285-296.
- Lynch, M. (1991) Laboratory space and the technological complex, *Science in Context* 4, 51-78;
- Merton, R. K. (1951) The social psychology of housing. In W. Dennis et al. (ed.) *Current Trends in Social Psychology* University of Pittsburgh Press, Pittsburgh. 163- 217.
- Ministry of Housing and Local Government (1961) *Homes for Today and Tomorrow*, H.M.S.O., London.
- Ophir, A, S. Shapin, S, Schaffer (eds) (1991) The place of knowledge: The spatial setting and its relation to the production of knowledge, *Science in Context* 4 Theme Issue.
- Pickles, A.T. (1949) Post-war research on heating and ventilation at the Building Research Station, *Journal of the Institution of Heating and Ventilation Engineers* 17, 64-105.
- Picon, A. (1999) Architecture, science and technology. In P. Galison. and E. Thompson (eds), *The Architecture of Science*. The MIT Press, Cambridge, Mass.
- Power, A. (1993) *Hovels to Highrise*. Routledge, London.
- Ravetz, A. (2001) *Council housing and culture: the history of a social experiment*. Routledge, London and New York.
- Shapin, S. (1988) Here and everywhere: Sociology of scientific knowledge, *Annual Review of Sociology* 21, 289-321.
- Studer, R.G. (1969) The dynamics of behaviour-contingent physical systems. In G. Broadbent and A. Ward (eds) *Design Methods in Architecture*. Lund Humphries for the Architectural Association, London.
- unknown a, (1949) Warm air house heating, *R.I.B.A. Journal* 56, 360-361.
- Weston, J. C. (1949) Heating Research in Houses *Journal of the Institution of Heating and Ventilation Engineers* 17, 235-267.